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Associations between animal welfare indicators and *Campylobacter* spp. in broiler chickens under commercial settings: A case study

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ABSTRACT

Few studies have previously investigated how poor animal welfare might be associated with infection of zoonotic pathogens in humans. This paper assesses the predictive value of the presence of *Campylobacter* spp. in broiler chicken flocks when animal-based measures related to footpad dermatitis, hock burns, body lesions and arthritis are identified under commercial conditions (high density). The study population included 32 flocks analysed on farm and at slaughter, slaughtered between April and August 2008 in six different slaughter plants in Brittany, France. Welfare and health indicators are those indicated by the European legislation and sampling was carried out in the framework of the European baseline survey on the prevalence of *Campylobacter* in broiler chicken. Caecal contents, sampled both on farm and at slaughter, and carcass skin samples from the neck and breast at slaughter, were investigated for the presence of *Campylobacter* spp. Logistic models/classification trees were used to estimate the probability of the presence (or absence) of a specific foodborne pathogen in a flock based on specific animal-based measures (or combinations of measures) in order to study the potential relationship between welfare indicators and foodborne pathogen prevalence/incidence levels. On farm, flocks with more than 25% animals with severe lesions on between 25 and 50% of the footpad are predicted to be *Campylobacter*-positive whereas flocks where less than 13 individuals have arthritis are predicted to be *Campylobacter*-negative. The error rate on farm and at slaughter was 10 and 4% respectively indicating good predicting abilities. A poor welfare environment may result in stress, which reduces chicken immunocompetence making them more susceptible to *Campylobacter* spp. An infection with *Campylobacter* spp may lead to impaired defence and susceptibility to other pathogens which may result in greater intestinal excretion. Poor welfare and high growing rate lead to digestive troubles that lead to litter humidity. Litter humidity that, among other things, causes footpad dermatitis may also influence the horizontal transmission of the *Campylobacter* spp. infection due to the normal coprophagic behaviour of poultry. Reducing welfare problems by a better management of rearing conditions would not only improve broiler welfare, but it would also decrease the risks of *Campylobacter* contamination, of carcass condemnations and of economic loss for the poultry industry.

1. Introduction

It has been suggested that animal-based welfare measures should be used to assess the most relevant welfare concerns in broiler farming (EFSA, 2012). They indicate the health status and wellbeing of the animals, but their predictive value for food safety remains largely uninvestigated. The Welfare Quality® project focused on animal-based measures to be monitored at slaughter to assess levels of welfare in a standardised way (Keeling, 2009). Some animal-based measures such as footpad dermatitis, hock burns and breast burns, are currently collected in fulfilment of European legislation (Council Directive 2007/43/EC). These animal-based measures are visually detected and recorded at slaughter (EFSA, 2012); however, different scoring categories and definitions are used *e.g.* for contact dermatitis (Algers and Berg, 2001;

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Allain et al., 2009; Michel et al., 2012) and significant variability exists in the measures and related scoring system used (Butterworth et al., 2015). According to the Directive 2007/43/EC, Annex III states that information regarding mortality rate on farm should be recorded at the slaughter plant. Moreover, in the *post-mortem* inspection, the official veterinarian has to identify any possible indications of poor welfare, such as abnormal levels of contact dermatitis, parasitism and systemic illness. In the case of findings consistent with poor welfare, the official veterinarian has to communicate these to the owner and to the local competent authorities. Although resources and management inputs may be correctly applied according to legislations, this does not guarantee high standards of animal welfare.

Competent authorities are also responsible for monitoring relevant food safety parameters on carcasses according to Regulation EC 2073/2005 and may have national voluntary monitoring programmes in place. Therefore, databases at slaughter plants can be exploited for data containing both chicken welfare and food safety information.

In Europe, thermotolerant *Campylobacter* continues to be the most reported gastrointestinal bacterial pathogen in humans (71 per 100,000 habitants in 2014). More than 80% of the human campylobacteriosis in Europe is caused by *C. jejuni* while *C. coli* is responsible for 7% of the human cases (EFSA and ECDC, 2015). Infection by thermotolerant *Campylobacter* is not considered a health problem in poultry (Wagenaar et al., 2013). No clinical signs or mortality are noticeable in *Campylobacter* infected poultry. Therefore, the current meat inspection system, relying on Food Chain Information analysis and on visual inspection of birds and carcasses, is of no use for detecting poultry contaminated with *Campylobacter*. It is also known that intensive farming favours shedding and horizontal transmission of *Campylobacter* spp. in poultry (Cogan et al., 2007; Bull et al., 2008; Verbrugghe et al., 2012). Bull et al. (2008) found that *Campylobacter*-positive flocks were associated both with a higher level of rejections at slaughter, because of gross pathology lesions due to general infections, and because of digital dermatitis. The increased incidence of hock marks and footpad dermatitis in fast-growing breeds infected with *Campylobacter* (Williams et al., 2013) affects welfare. Hock marks and footpad dermatitis are painful conditions, which reduce welfare in broiler chickens (EFSA, 2012). Infectious and non-infectious arthritis are also painful conditions in broilers and can cause lameness (EFSA, 2012). Infectious arthritis may be caused by a number of different pathogens (virus, bacterial, mycoplasma). It can also be the consequence of systemic infection or cellulites of the hock caused by contact with faecal material (i.e. litter related) (Xavier et al., 2010). Non-infectious arthritis is related to genetic selection in broiler chicken (Bradshaw et al., 2002).

The objective of this paper is to assess the predictive value for the presence of *Campylobacter* spp. in flocks when animal-based measures related to footpad dermatitis, hock burns and body lesions are identified within flocks from commercial settings. The article is intended as a case study to generate hypotheses. Based on our findings we provide recommendations on the best animal-based measures to estimate the probability of flocks being *Campylobacter*-positive.

2. Material and methods

2.1. Study population and study design

Sampling was carried out in January-December 2008, within the framework of the EU baseline survey on the prevalence of *Campylobacter* in broiler chicken. The epidemiologic unit was the slaughtered flock, previously placed in the house at the same time. The study population included 32 flocks of broiler chicken analysed both on farm and at slaughter; the flocks were slaughtered between April and August 2008 in six different slaughter plants in Brittany, France. Each flock belonged to a conventional farm (i.e. no free-range or organic farms) and included on average 27523 ± 9239 (SD) animals (range: 12046–54523). The two main genotypes represented were Hubbard (44%) and Ross (37%). Broiler age at slaughter was on average 38 ± 5 days (range: 28 – 47 days) and the average slaughter weight was 1.77 ± 0.53 kg (range: 1.25–3.19 kg). The average mortality at day 10 of the rearing period was 1.37% ± 0.31 (1.06–1.69 95% CI) and mortality at the end of the rearing period was 2.13% ± 0.39 (range: 1.74% – 2.52%). Flocks were not thinned.

2.2. Sample collection on farm and at slaughter

The method for collection of samples was the same as that described by Allain et al. (2014). On farm, five broilers per flock were euthanized with pentobarbital; their caecal contents were collected and pooled in a sterile bag one week before slaughter.

Sampling collection at the slaughter plant was carried out according to Hue et al. (2011). Caecal content from 10 randomly selected broilers per flock were collected at evisceration and pooled in a sterile bag. From the same flock one randomly-chosen carcass was collected after chilling. From this carcass, neck and breast skin samples were collected. All the samples were investigated for the presence of *Campylobacter* spp.

Bacteriological analyses were carried out within 24 h from sample collection at the French National Reference Laboratory for *Campylobacter* (French Agency for Food, Environmental and Occupational Health- Anses).

2.3. Welfare assessment at slaughter

At the slaughter plant, animal-based welfare measures were scored on a random sample of almost 400 carcasses per flock, inspected on the slaughter line after scalding. Any sign of contact dermatitis was recorded (Allain et al., 2009). Five body areas were defined for welfare scoring: i) footpad, ii) digits, iii) tarsus, iv) ventral side of body and v) dorsal side of body.

Footpad lesions were recorded according to a 10-point scale (Table 1).

Digit lesions were scored on a 5-point scale where score 0 indicated no dermatitis, score 1–4 depending on the presence of dermatitis and the number of toes affected. Tarsus lesions were recorded on a 7-point scale and arthritis was also recorded (Table 2).

The dorsal area of the carcass was inspected to record the presence of scratches and haematoma (Table 3). The ventral area of the carcass was inspected to record signs of swelling, crusts, pustules, haematoma and scratches (Table 4).

For footpad, digits, tarsus and carcass body scoring areas, a composite score was also determined, which is described below.

2.4. Overall score of animal-based measures

An Overall Score Measure (OSM) for each of the four types of measures (Tables 1–4) was calculated using the following equation which considers the number of animals in each of the categories, weighted according to the severity and standardized by the number of categories recorded.

Table 1
Scoring system for footpad lesions.
(Source).

	Extent (%) of the foot pad affected		
Foot lesion	< 25	25–50	> 50
No lesions	P0		
Keratosis/papilloma	P1	P2	P3
Superficial lesion (crust)	P4	P5	P6
Severe lesion (ulcer)	P7	P8	P9
Healing	P10		
Overall score	OP		